DaimlerChrysler AG

Patent Claims

1. A method for operating an internal combustion engine (1) with compression ignition, in which

- fuel is injected into a combustion chamber (8) in the form of a plurality of fuel jets (17) by means of an injection nozzle (13) which has a nozzle needle (13a) and injection bores (21),
- during an injection process some of the fuel is injected as a main injection (MI) and
- at a later time following the main injection (MI) a fuel quantity is injected as a cyclical postinjection (PI),

characterized in that

- the postinjection (PI) is injected cyclically in partial quantities, in such a manner that the partial quantities of fuel of the postinjection (PI) are formed in different magnitudes.

2. The method as claimed in claim 1, characterized in that during the cyclical postinjection (PI), a lift of the nozzle needle (13a) of the injection nozzle (13) and/or a fuel injection pressure are set in such a manner that for each partial quantity of the postinjection (PI) injected into the combustion chamber (8) the reach of the respective fuel jet (17) in the combustion chamber is limited in such a manner that the reach is less than the distance to a combustion chamber boundary.

3. The method as claimed in claim 1 or 2, characterized in that a first partial quantity of fuel of the postinjection (PI) is made to be greater than a

subsequent quantity of fuel of the postinjection (PI).

4. The method as claimed in one of the preceding claims, characterized in that the postinjection (PI) is injected into the combustion chamber (8) at a lower injection pressure than that of the main injection (MI).

5. The method as claimed in one of the preceding claims, characterized in that the main injection (MI) is begun in a range from 10°CA before top dead center to 20°CA after top dead center.

6. The method as claimed in one of the preceding claims, characterized in that the postinjection (PI) is begun in a range from 30°CA to 100°CA after the end of the main injection (MI).

7. The method as claimed in one of the preceding claims, characterized in that the postinjection (PI) takes place in two to eight cycles in an expansion stroke in a range from 20°CA to 150°CA after top dead center.

8. The method as claimed in one of the preceding claims, characterized in that part of the fuel is injected as a cyclical preinjection (PRI) with an injection pressure which is less than or equal to that of the main injection (MI).

9. The method as claimed in one of the preceding claims, characterized in that the preinjection (PRI) is injected in a range from 140°CA to 60°CA before top dead center.

10. The method as claimed in one of the preceding claims, characterized in that the main injection (MI) is carried out in a range from 5°CA to 30°CA after an

ignition point of the preinjection (PRI) into the combustion chamber (8).

11. The method as claimed in one of the preceding claims, characterized in that the fuel quantity of the preinjection (PRI) in a lower and medium load range is approximately 20% to 50% of the fuel quantity of the main injection (MI) and in an upper load range or full load range is approximately 10% to 30% of the fuel quantity of the main injection (MI).

12. The method as claimed in one of the preceding claims, characterized in that during the postinjection (PI) and/or the preinjection (PRI), a cloud of fuel, generated during an injection cycle, of a fuel jet (17) is offset or laterally shifted by means of a swirling motion formed in the combustion chamber (8).

13. The method as claimed in one of the preceding claims, characterized in that the lift of the nozzle needle (13a) of the injection nozzle is set in such a manner that a non-steady-state cavitational flow is generated in the injection bores (21) of the injection nozzle (13).

14. The method as claimed in one of the preceding claims, characterized in that the lift of the nozzle needle (13a) of the injection nozzle (13) is varied in such a manner that within the injection nozzle (13) an effective cross section of flow between the nozzle needle (13a) and a nozzle needle seat (22) amounts to approximately 0.8 to 1.2 times an effective cross section of flow of the sum of all the injection bores.

15. An injection nozzle for carrying out the method as claimed in one of claims 1 to 14, which has an inwardly opening nozzle needle (13a) and a plurality of injection bores (21), characterized in that a spray

hole cone angle of from 80° to 140° can be set between the injected fuel jets (17).

16. The injection nozzle as claimed in claim 15, characterized in that the lift of the nozzle needle (13a) of the injection nozzle (13) can be set in such a manner that within the injection nozzle (13) an effective cross section of flow between the nozzle needle (13) and the needle seat (22) amounts to approximately 0.8 to 1.2 times an effective cross section of flow of the sum of all the injection bores (21).

17. The injection nozzle as claimed in claim 16, characterized in that the lift of the nozzle needle (13a) can be set by means of a two-spring holder, a piezo-controlled nozzle needle or a coaxial variable nozzle.